**A very simple demonstration to show that forces in a collision are the same no matter how big the things colliding are**

Students believe that when a truck and a car collide the car experiences the greatest force

When a fly runs into the front windscreen of a train students always say the fly has the greatest force on it.

When a golf club hits a ball students say that the ball has a greater force on it than the club

In all these cases above it is not true that the forces are different. It is the **accelerations** that are different (because they have different masses) but the forces at any instant of the collision are equal and opposite. This is Newton’s Third Law.

How to you convince students that this is true?

You will need two sets of (mechanical) weighing machines like the ones you find in the bathroom (used to weigh yourself). The electronic ones do not seem to work. You need to have something that a student could sit on like a trolley used for pushing equipment around the laboratory. I used my car and had the students sitting on the bonnet of the car. The dents in the bonnet are still there.

[](http://www.angryretail.com/store/images/goodies/detail/celeb_scales.jpg)

Get one large student and one smaller student from the class

Get each student to hold the scales in front of them with the dial pointing towards them. Do not wrap their fingers around the scales. It will hurt them when they push against the other person!!

Ask the students in the class which scale will read the most when they push against each other. If they say the same then your students are brilliant. Most students say the smaller person will have the larger force on them

Now get them to come together and let the two sets of scales touch each other. Now push and get them to read the scale’s reading. The readings on the scales will be the same (there will be minor differences but they are usually very small).

Now get them to push as hard as they can and call out what the scales read. It may be helpful to get someone else in the class to read the scales for them as the two students are too busy pushing.

Ask what they get from these result

If you can, see if you can get the large person to push the smaller person so hard that the smaller person starts to move. Read out the scales readings in this case. This is when the students get really confused because the readings are the same. They want to know how the smaller person can move of the readings are the same.

Time for a discussion (in groups)

Now get two different people and have one sit on a trolley and another pushing while holding the scales. The amazing thing is that the two sets of scales read the same values. The forces are the same (but in opposite directions)

Now get as many people as you can sitting on the trolley. Have one of them hold the scales and one person on the ground pushing. (this is when my car bonnet got dented) What happens now?

This is when it is a good idea to get them to sit in groups and discuss examples of collisions and try to do the following for instance

Say if they think the forces are the same (with reasons for their answers)

What is happening to the smaller one and why it often suffers most damage or flies off faster.

**Time for some theory**

By the way, this happens on the Earth and is why when we walk on the Earth (without slipping) we “move:

Force on the Earth and the person’s feet are the same but in opposite direction. Suppose the force is 100N and the person has a mass of 100kg

The acceleration on the 100kg person =F/m =100N/100kg=1m/s2

The acceleration on the Earth is F/m = 100N/6.4x1024kg=1.6x10-23m/s2

It would take the Earth about 12100 years to move 1mm because it is so massive!!!

The Earth also moves but not far. It would take the man .07 seconds to move 1mm. That is why we can easily walk over the Earth.

Force on person’s feet 100N

Force on the Earth 100N

So the reason than golf ball flies off from the golf club is because it has less mass and so greater acceleration that the club

The fly and the truck have the same force on them. The fly comes to a quick stop because the acceleration of it is huge because it has such a small mass. The truck’s acceleration is tiny and cannot be noticed.

Newton’s Second Law can be written

In words a **force times the time the force acts gives the change in momentum**

Force on Oval F

Force on square F

Force on square = Force on Oval

Therefore the total force on them both= 0

So That means the total change in momentum on them both =0

So the total momentum before the collision (the momentum of the square and ova)l before the collision= the total momentum of them both after the collision

**So TOTAL momentum is conserved in a collision**